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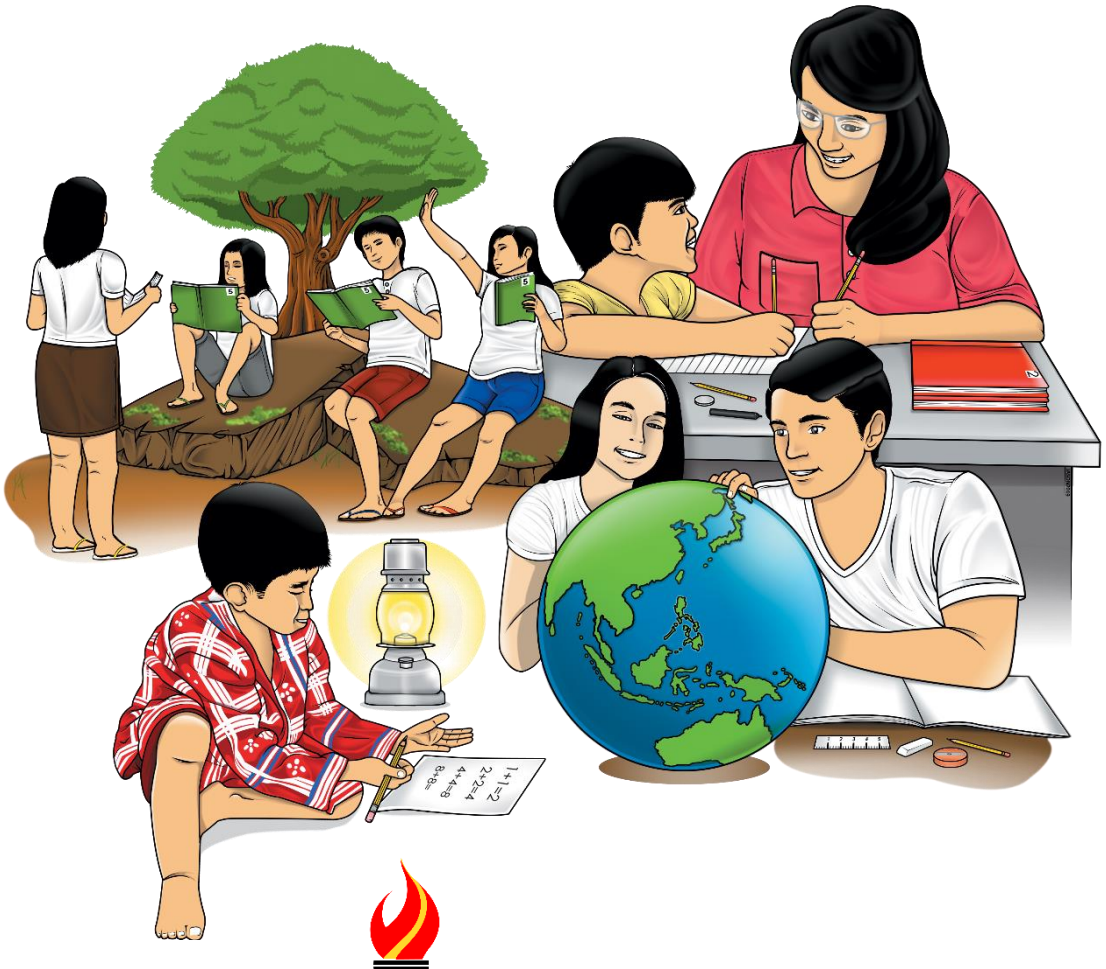
DEPARTMENT OF EDUCATION

Science
Quarter 2- Matter
Module 2: Chemical Bonding: Properties of Compounds



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Science
Quarter 2- Matter
Module 2: Chemical Bonding: Properties of Compounds

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

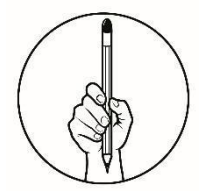
This module is designed and written with you in mind. It is here to help you master Chemical Bonding: Properties of Compounds. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course, but the order in which you read them can be changed to correspond with the textbook you are now using.

The module focuses on achieving this learning competency:

Recognize different types of compounds (ionic or covalent) based on their properties such as melting point, hardness, polarity, and electrical and thermal conductivity. (S9MT-IIb-14)

After going through this module, you are expected to:

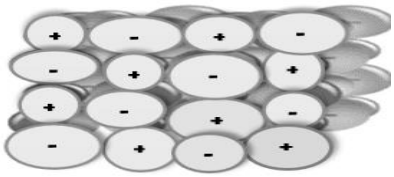
- identify and describe ionic and covalent compounds based on their chemical formula and chemical names;
- enumerate and discuss different physical properties of ionic and covalent;
- distinguish ionic from covalent compound based on their physical properties; and
- cite a natural phenomenon that uses different physical properties of ionic and covalent compound (ex. Snowflakes, voltaic cells).



What I Know

Choose the letter of the best answer. Write your answer on a separate sheet of paper.

1. The figure below represents the arrangement of particles in a substance. What kind of substance is this?



   A. Ionic compound
   B. Metallic compound
   C. Covalent compound
   D. None of these

2. Which is a property of ionic compound?
   A. soft and flexible
   B. crystal lattice structure
   C. liquid or gaseous state at room temperature
   D. does not conduct electricity both in solid and melted form

3. Which is **NOT** a property of covalent compound?
   A. It has low melting point
   B. It exists in a stable crystalline structure.
   C. It does not exhibit any electrical conductivity.
   D. It is usually solid at normal temperature and pressure.

4. Which gives the best explanation of why a solid ionic compound **DOES NOT** conduct electricity?
   A. Solid ionic compounds do not have ions.
   B. Solid ionic compounds are not soluble in water.
   C. Solid ionic compounds have ions which are free to move.
   D. Solid ionic compounds have ions, but these ions are not free to move.

5. Which substance conducts electricity when dissolved in water?
   A. gasoline
   B. paraffin wax
   C. sugar
   D. monosodium glutamate

6. Which of the following statements **BEST** explains the high solubility of sodium chloride (NaCl) in water?
   A. The ions are free to move.
   B. There are positive and negative ions present in the substance.
   C. Sodium chloride break apart into molecules, not an individual atom when dissolve in water.
   D. The positive and negative ions are attracted to different regions of the polar water molecules.

7. Which of the following substances **DO NOT** exist in solid, liquid, or gas at room temperature and normal atmospheric pressure?

I. gasoline	III. salt
II. snowflakes	IV. water

A. A. I only B. II only C. III only D. III and IV only

8. Why do ionic compounds tend to be less flammable than covalent compounds?
   A. Ionic compounds are poor conductor of heat.
   B. Ionic compounds do not have carbon and hydrogen atoms that react when heated with oxygen gas.
   C. Ionic compounds contain atoms that can react to form carbon dioxide and water when heated with oxygen gas.
   D. None of these

9. Why do ionic compounds conduct electricity when dissolved in water, but most covalent compounds do not?
   A. Covalent compounds have lower melting point than ionic compounds.
   B. Covalent compounds are weakly bonded while ionic compounds are strongly bonded.
   C. Covalent compounds do not dissolve in water since they are composed of non- polar molecules.
   D. Covalent compounds dissolve into molecules, while ionic compounds dissolve into ions that conduct charge.

10. Snowflake is an example of compound that begins to form when an extremely cold-water droplet freezes into a pollen or dust particle in the sky. Which is **TRUE** about a snowflake?
   A. Its chemical formula is the same as water.
   B. Its structure is the same as the crystalline lattice of an ionic compound.
   C. It is formed due to the transfer of electrons from two oxygen atoms to a hydrogen atom.
   D. It is formed when a raindrop freezes due to a very low temperature in the atmosphere.

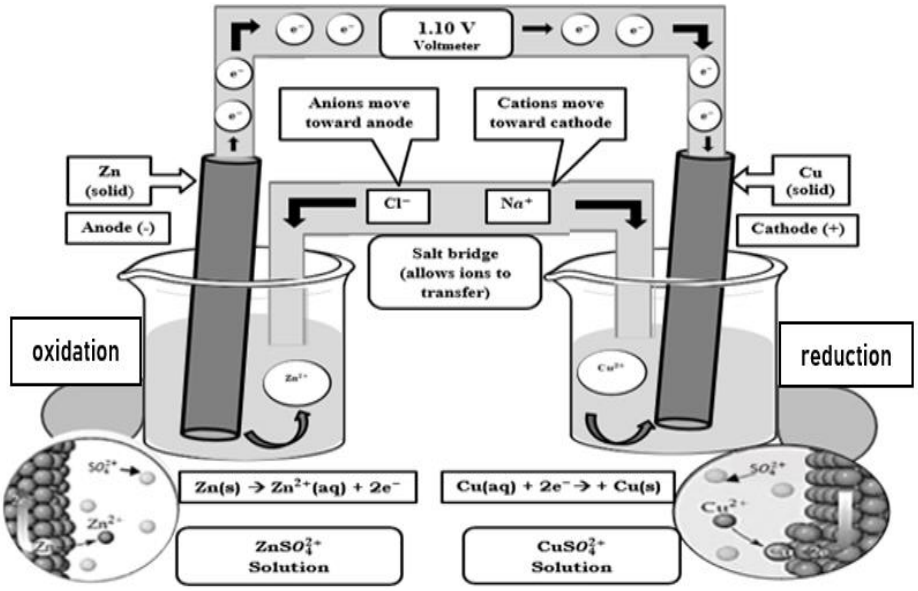
11. Why are some snow crystals big and complicated, but others are small and simple looking? Because…
   A. they differ in composition
   B. some have ionic bonding, while others have covalent bonding
   C. they differ in temperature and humidity of the cloud where they are formed
   D. the big ones are made up of saltwater while the small ones are made up of fresh water.

12. The table below shows the result for electrical conductivity test of $PbBr_2$, $C_{10}H_8$ and NaCl. Based on the results, what can you conclude about the three substances tested?

State of Compound	**Lead (II) bromide** ($PbBr_2$)	**Naphthalene** ($C_{10}H_8$)	**Sodium chloride** (NaCl)
Solid	Light bulb does not light up.	Light bulb does not light up.	Light bulb does not light up.
Aqueous solution	Bulb lights up.	Light bulb does not light up.	Bulb lights up.

A. PbB, $C_{10}H_8$ and NaCl are all ionic compounds.
B. PbB and $C_{10}H_8$ are covalent while NaCl is ionic.
C. $C_{10}H_8$ is covalent while PbB and NaCl are ionic.
D. PbB is an ionic compound while $C_{10}H_8$ and NaCl are covalent compounds.

For item no. 13-14, refer to the figure below:



13. Which of the following is/are **TRUE** about voltaic cells as shown in the diagram below?

I. The reaction that takes place in it is reversible.
II. They have two conductive electrodes, a positive and negative electrode.
III. It is a device that produces electric current from energy released by spontaneous reduction-oxidation reaction.

A. I only
B. II only
C. I and II only
D. II and III only

14. Which of the following shows the correct analogies using the information you can get from the diagram?

I. anode-reduction: cathode oxidation
II. anode-oxidation: cathode reduction
III. positive electrode – anode: negative electrode - cathode
IV. positive electrode – cathode: negative electrode – anode

A. II only
B. IV only
C. I and III only
D. II and IV only

15. When humans sweat, we lose ions necessary for bodily functions; to replenish them, we consume more ions, often in the form of an electrolyte solution. In a sports drink, which compound is **NOT** considered as electrolytes?

A. glucose
B. sodium
C. potassium
D. magnesium

Lesson 1 Chemical Bonding: Properties of Compounds

In the previous module, you have learned how the development of atomic models like the Quantum Mechanical Model of the atom lead to the description of the behavior of electrons within atoms. In this module, you will focus on how the different types of compounds (ionic or covalent) can be recognized based on their properties such as melting point, hardness, polarity, and electrical and thermal conductivity.

Here are some key questions for you to ponder after finishing this module:

1. How will you identify and describe ionic and covalent compound based on their chemical formula and chemical name?
2. What are the different physical properties of ionic and covalent compounds?
3. How will you distinguish ionic from covalent compound based on their physical properties?
4. What are the different natural phenomena that uses different properties of ionic and covalent compound?

What's In

The modern periodic table organizes elements in such a way that information about the elements and their properties are easier to understand and remember. For example, the vertical column of the periodic table is called ***group***, elements in the same group share common properties. Classify the elements from the box below according to the group where they belong to complete the list of representative elements. Use the chemical symbol of the element in answering. Write your answer on a separate sheet of paper.

Lead	Helium	Barium
Boron	Oxygen	Aluminum
Argon	Chlorine	Potassium
Radon	Nitrogen	Magnesium
Sodium	Hydrogen	Phosphorous

1 IA	2 IIA		13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
Li	Be	TRANSITION METALS		C			F	Ne
				Si		S		
	Ca		Ga	Ge	As	Se	Br	Kr
Rb	Sr		In	Sn	Sb	Te	I	Xe
Cs			Tl		Bi	Po	At	
Fr	Ra			Fl		Lv		

Figure 1: Periodic Table of the Representative Elements

What's New

Getting to Know Chemical Compounds

Most elements bond with other elements to form chemical compounds. The table below shows the list of commonly used chemical compounds. Identify the name of elements included in the given compound and determine whether the elements are metal or non-metal. Answer for number 1 item is provided as an example. Write your answer on a separate sheet of paper.

Compounds	Name of Elements Involved	Types of Elements
1. Water (H_2O)	Hydrogen Oxygen	Nonmetal Nonmetal
2. Sugar ($C_{12}H_{22}O_{11}$)		
3. Potassium chloride (KCl)		
4. Carbon Dioxide (CO_2)		
5. Sodium Chloride (NaCl)		

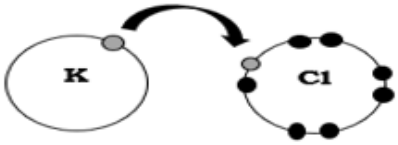
Guide Questions:

1. How do compounds form?
2. What does a compound contain?

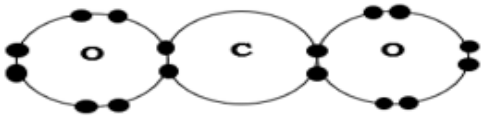
What is It

Let's Bond with Ionic and Covalent Compounds

Compounds play a big part in our everyday life, like for example, you can find compounds present in food, air, cleaning chemicals, and literally in every object that you can see or touch. Compounds are made up of elements that are chemically bonded by electrostatic forces. Compounds can be classified as ionic or covalent. An ionic compound is formed when metal (cation) transfers its valence electron/s to a nonmetal (anion). The covalent compound is formed when nonmetals share their valence electrons with another nonmetal. The figure below shows an illustration on how each element transfer or share their valence electrons to attain stability.



Potassium Chloride (KCl)
Ionic Compound



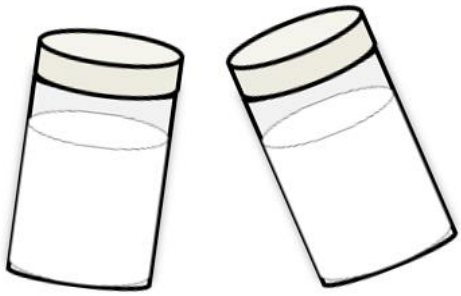
Carbon Dioxide (CO_2)
Covalent Compound

Identifying and Describing Compounds through its Chemical Formula and Chemical Name

Ionic and covalent compounds can be identified and described through their chemical formula and name by observing the types of elements involved in a compound. In chemistry, the **chemical formula** is a symbolic expression **signifying the number of atoms present** in a molecular substance. We determine the type of atom by referring to its chemical symbol. The **number of atoms is determined by the subscript attached to the symbol**. On the other hand, chemical name shows the name of each element involved in a compound. For example, **carbon dioxide**, the chemical formula is written as **C**O_2. This means that this is an example of a covalent compound, since the elements involved are nonmetals, namely, one carbon atom and two oxygen atoms. Moreover, **sodium chloride**, which chemical formula is written as **NaCl** is an example of an ionic compound. Since the elements involved in a compound are sodium (Na) a metal and chlorine (Cl) a nonmetal. Take a look at your answer in the table of compounds in the **"What's New"** part of this module. Which among the given compounds do you think can be classified as ionic and covalent compounds based on their chemical formula and name?

Mara is preparing a lunch for her family. While gathering all the ingredients for her recipe, she is a bit confused between the two identical canisters. One canister contains salt (NaCl) and the other contains sugar ( ). Both contents are white powder solid in appearance at room temperature. Without tasting the sample compounds in the canister, how do you know if a compound is salt (ionic) or sugar (covalent)?

Which is which?
Is it salt or sugar?



Understanding the Different Properties of Compounds

Ionic and covalent compounds have different physical properties that will help distinguish them.

1. At normal atmospheric pressure and temperature, covalent compounds may exist in solid, liquid, or a gas, while ionic compounds exist only as crystalline solids.

The reason for this is, in covalent compounds, electrons are shared and no full ionic charges are formed, which makes; the molecules in this compound not strongly attracted to one another compared to ionic compounds. Thus, covalent molecules move freely and tend to exist as liquid or gas at room temperature like alcohol, which is widely used as a disinfectant, fuel, and as a main component of alcoholic beverages.

Most ionic compounds do not actually exist as molecules; instead, the ions are arranged in an alternating positive and negative ion bonded together in a matrix. As a result, the ions are held rigidly together in their crystal lattice structure, and that is why they are solid under normal atmospheric pressure and temperature, like for example sodium chloride (NaCl), which is commonly used for flavoring and preserving foods.

2. Ionic compounds generally have higher melting and boiling points while covalent compounds have lower melting and boiling points.

Ionic compounds have high melting and boiling point because it takes a lot of thermal energy for ions (charged atoms) in the crystal to separate them apart from each other. On the other hand, covalent compounds have low melting and boiling point because of the weak force of attraction between molecules. As a result, a small amount of thermal energy can separate them.

3. Ionic compounds are hard and brittle, while covalent compounds are soft and flexible.

Crystal lattices are among the factors that affect the hardness and brittleness of compounds. This refers to the symmetrical three- dimensional arrangement of atoms inside a crystal. The crystal lattices of ionic compounds are hard and not easily scratched, however, it is brittle, which can lead changes to its shape or size. In contrast, covalent compounds have molecules that are weakly attracted to each other and are easily displaced.

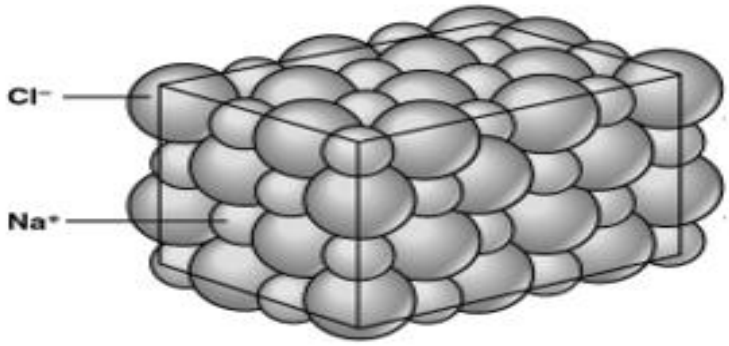


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Figure 3: Crystal Lattices of Sodium Chloride (NaCl)

4. Ionic compounds have high polarity, while covalent compounds have low polarity.

Polarity, in a compound, results in the distribution of electrical charge over the atoms joined by a chemical bond. In a chemical bond, polarity arises from the relative electronegativities of the elements. Electronegativity refers to the ability of an atom to attract electrons toward itself in a chemical bond.

To determine the polarity of compounds, we simply determine the electronegativity difference (EN) of a compound by subtracting the electronegativity value of the elements involved in a compound. If the difference in EN values between the metallic element and non-metallic elements is greater than 1.9 the compound is considered as ionic in character. Covalent compound may result in polar or nonpolar bond. Polar covalent bond results when the EN difference of two non-metallic elements is equal to 0.5 and lower than 1.9. On the other hand, nonpolar covalent bond results when the EN difference of non-metallic elements is lower than 0.5. Two identical non-metallic elements (diatomic molecules) always produce nonpolar covalent bond like nitrogen gas (N_2), oxygen gas (O_2), and hydrogen gas (H_2).

Example:

Compound	Electronegativity (EN) Value	Electronegativity (EN) Difference	Polarity
1. Sodium Chloride (NaCl) Sodium Chlorine	 0.9 3.0	4.0 – 0.9 = 2.1	Ionic
2. Water (H_2O) Hydrogen Oxygen	 2.1 3.5	3.5 -2.1= 1.4	Polar covalent
3. Hydrogen gas (H_2) Hydrogen Hydrogen	 2.1 2.1	2.1 – 2.1= 0	Nonpolar covalent

5. Ionic compounds are usually soluble in water, while covalent compounds tend to be less soluble in water.

Solubility is the ability of a substance that may exist in solid, liquid, or gas form, referred to as the solute, to dissolve in solvent. Many ionic compounds are highly soluble in water because water molecules, a polar solvent attract each of the ions of an ionic compound and pull the ions away from one another. However, ionic compounds are less soluble in solvents that contain a common ion. On the other hand, some covalent compounds are not soluble in water: they do not dissolve well in water. Compounds that have similar properties (particularly polarity), tend to dissolve in each other. This concept is often expressed as "Like dissolves like" but for substances with unlike polarities, like water and oil, where water is polar and oil is nonpolar, these two substances are insoluble with each other.

6. Ionic compounds tend to be less flammable than covalent compounds.

Flammability refers to the ability of a chemical substance to burn causing fire. Combustion happens when substances containing carbon and hydrogen reacted with oxygen gas and it will form carbon dioxide (CO_2) and water (H_2O). For example, organic compounds which are mostly found together in covalent compounds burn because they contain carbon and hydrogen. As a result, more covalent compounds tend to be more flammable than ionic compounds. However, not all covalent compounds burn. For instance, water, though a covalent, has molecule which is bonded with a polar covalent—that is why it is hard to start fire with it.

Liquefied Petroleum Gas (LPG) is an example of covalent compound that contain flammable mixture of hydrocarbon (hydrogen and carbon) gases. It is usually used as fuel in cooking equipment, heating appliances, and vehicles. The flammability property of this compound require all the liquefied petroleum gas (LPG) industry participants to observe the minimum safety standards in the transportation and distribution of the petroleum product in cylinders under the mandated order of the Department of Energy (DOE), stated in their department circular (DC) 2014-01-0001 or the "The LPG Industry Rules".

7. **Ionic compounds conduct heat and electricity compared to covalent compounds.**

The conductivity of a substance refers to its ability to transmit heat and electricity. In a chemical bond, ionic compounds are generally considered a good conductor of electricity when dissolved or in an aqueous solution. This is because of the presence of mobile ions (solid electrolytes) in ionic compound that can transfer electrical charge. Ionic compounds are also considered as good conductor of heat because the ions are all next to each other, making it possible for energy to be transferred efficiently from one place to another.

Covalent compounds, on the other hand, are considered as good insulators of both electricity and heat. This is the reason why that there are no mobile charged particles and electrons are shared by atoms in a covalent bond. Moreover, covalent compounds have molecules that are not as tightly held to each other compared to ions in an ionic compound. As a result of this, heat does not travel well, making heat transfer less efficient.

Take note, these are only general properties, and there are always exceptions to every rule.

Natural Phenomena that Uses Different Properties of Ionic and Covalent Compounds

A. Frozen Fractals of Snowflakes

Have you been dreaming of a white Christmas here in the Philippines, wherein you can enjoy wearing your jackets while having a cup of hot chocolate over a fireplace? Do you think it is possible for us Filipinos to witness having snow in a yuletide season?

The Philippines is considered a tropical country, wherein according to PAGASA (Philippine Astronomical Geophysical Atmospheric Space Administration), we experience high relative humidity or moisture content of the atmosphere. Varying between 71 percent in March and 85 percent in September, high humidity levels are attributed to the high temperature and the bodies of water surrounding the archipelago. Back in 2017, there were reports of hailstones, or ice pieces, each about half an inch in diameter, falling over parts of Quezon City and Alabang. However, hailstone, which refers to a frozen form of precipitation, is different from the snow. Hailstone usually forms during a thunderstorm when upward moving air prevents ice particles from falling from the atmosphere, making it suspended in the air as supercooled water which freeze into the balls of ice.

In contrast, snow refers to small, soft, white pieces of ice. Snow is formed when the temperature is low and there is moisture in the atmosphere in the form of tiny ice crystals in clouds that stick together to become snowflakes. These snowflakes are three- dimensional pattern with six-sided symmetry. Each molecule that joins the snowflakes reflects the internal order of the crystal's water molecules until eventually, we can see its macroscopic six-sided shape. The chemical formula of snowflakes is the same as water molecules. Therefore, the intermolecular force found in snowflakes are a covalent bond. The hexagonal sides of snowflakes are the results of two hydrogen atoms and one oxygen atom that form "bent" molecular shapes. This is a result of the hydrogen bond that forms a dipole at the end of an oxygen atom. This enables the hydrogen side to be positively charged and the oxygen side to be negatively charged.

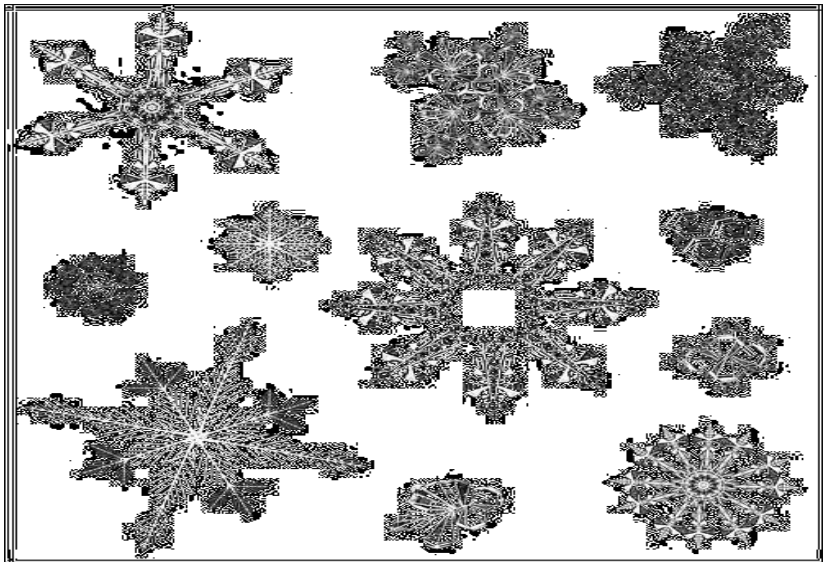

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Figure 4: Molecular Structure of Snowflakes

B. Chemical Reactions as a Source of Power

One of the priorities of the researchers nowadays is to explore the usage of chemical reactions to produce electricity. Understanding electrochemistry which refers to the study of chemical process that causes the movement of electrons to produce electricity, would greatly help reduce environmental problem that is caused by burning coals.

Galvanic cell which is known as voltaic cell is a type of electrochemical cell that uses chemical reaction to produce electric current, specifically an oxidation reduction reaction. A battery that powers your gadgets like cellphone is an example of voltaic cell.

The diagram below illustrates different parts and functions of voltaic cell.

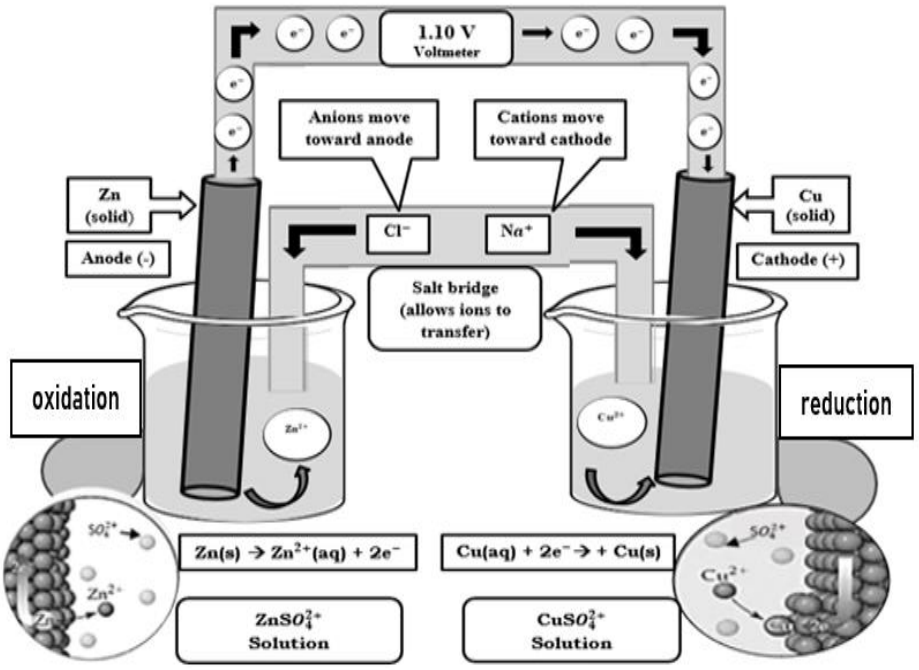


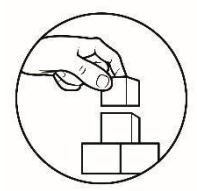
Figure 5: Basic Set-up of Voltaic Cell

In order to generate a flow of electric charge, a strip of metal: zinc (Zn) and copper (Cu) is placed in an aqueous solution containing the same metal, namely the Zinc sulfate ($ZnSO_4^{2+}$) and copper sulfate ($CuSO_4^{2+}$) solution. A piece of wire is hooked to connect a strip of zinc and copper metals, which causes the electrons, to move within the wire. Zinc, which has a weaker pull for electrons, loses electron, which goes through the wire which makes copper that has a strong pull for electron, gain electrons. After the zinc ions turns into Zn^{2+}, it is no longer a part of a solid zinc metal instead it becomes metal ions that dissolves in a solution ($ZnSO_4^{2+}$). On the other hand, when copper gained two electrons it becomes a neutral atom, that can no longer dissolve in the solution, instead it become a part of a solid copper metal.

In terms of chemical process, moving electrons create electricity, and flow from a piece of zinc that serve as an anode, site of oxidation to a piece of copper, which is the cathode, the site of reduction. These two reactions involve two half reaction of oxidation and reduction. The voltaic cells also include a salt bridge that balance the charges and allows the ions to flow from one half cell to another. In addition, a voltmeter is used to measure potential difference between two half cells.

Activity 1: Out with the Old, In with the New

Study the figures below that illustrate how ionic and covalent compound are formed and answer the guide questions that follow. Write your answer on a separate sheet of paper.



What's More

Figure A: Formation of Sodium chloride (NaCl).

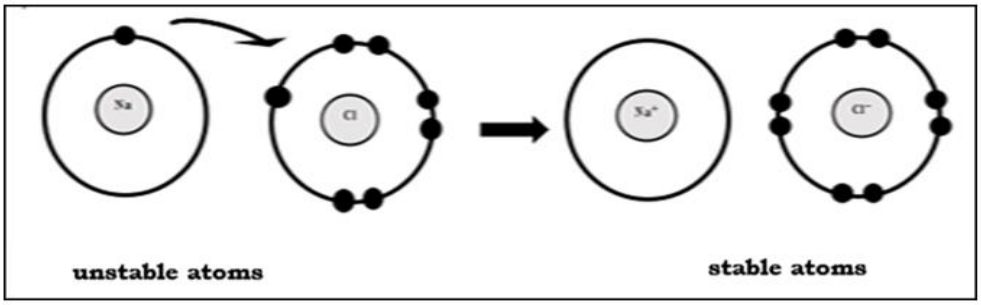
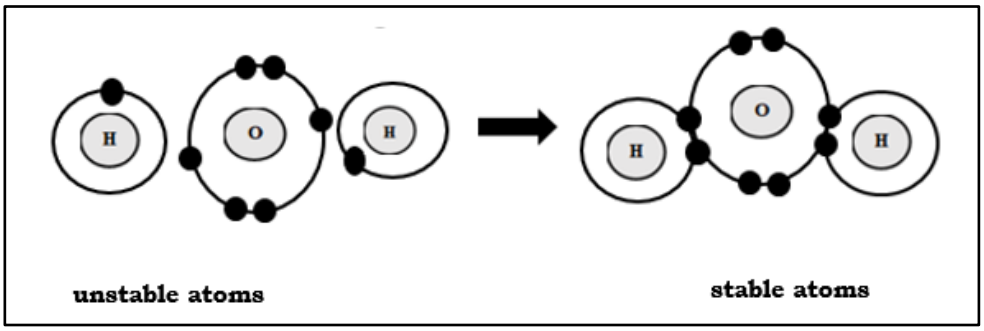


Figure B: Formation of water (H_2O).



Guide Questions:

1. What are the types of elements involved in the formation of the sodium chloride (NaCl) and water (H_2O)?

2. How do sodium chloride (NaCl) and water (H_2O) form?

3. What leads to the transfer or sharing of valence electron between elements in a compound?

4. What type of compound is sodium chloride (NaCl) and water (H_2O)?

5. How will you identify and describe ionic and covalent compounds based on how they are formed?

Activity 2: Know My Identity through My Chemical Formula

Study the list of compounds and its chemical formula below. Complete the table by identifying the correct chemical formula and classifying the type of compound for each item. Write your answer on a separate sheet of paper.

Chemical Formula		
H_2	H_2O	NaCl
N_2	CO	PH_3
HF	$MgCl_2$	KI
KF	BH_3	Al_2O_3
SO_2	HCl	$C_{12}H_{22}O_{11}$

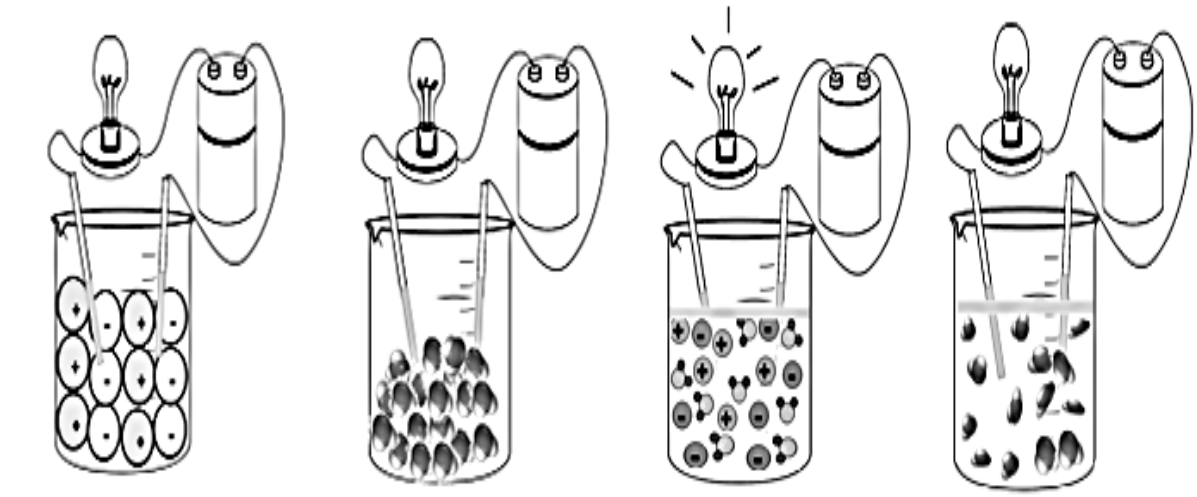
Chemical Name	Chemical Formula	Ionic/Covalent
1. Water		
2. Borane		
3. Phosphine		
4. Hydrogen gas		
5. Nitrogen gas		
6. Table sugar		
7. Sulfur dioxide		
8.Sodium chloride		
9.Aluminum oxide		
10.Carbon monoxide		
11.Hydrogen fluoride		
12.Potassium iodide		
13.Hydrogen chloride		
14. Potassium fluoride		
15.Magnesium chloride		

Guide Question:

- How will you describe and identify ionic and covalent compounds based on their chemical name and formula?

Activity 3: Who Got the Power?

Study the four experimental set-ups below testing the electrical conductivity of salt and sugar. Record your observation on the table. Write your answer on a separate sheet of paper.



A Salt Granules	**B** Sugar Granules	**C** Salt Dissolved in Water	**D** Sugar Dissolved in Water

Table 1: Electrical Conductivity of Salt and Sugar

Sample	Physical State of Sample Materials (solid/liquid)	Electrical Conductivity Yes/No
A. Salt Granules		
B. Sugar Granules		
C. Salt Dissolved in Water		
D. Sugar Dissolved in Water		

Guide Questions:

1. Which among the sample materials conduct electricity when dissolved in water?
2. Explain why salt can conduct electricity when dissolved in water but not in its solid state.
3. Why does sugar cannot conduct electricity in both solid and in a solution?
4. What type of compounds are sugar and salt?
5. What type of compound can conduct electricity?

Activity 4: Investigating Ionic and Covalent Profile

Imagine yourself as a young Filipino chemist in a laboratory. One of your assistants conducted a series of experiments using the different compounds as samples. Inefficiently, your assistant labelled the samples using uppercase letters without having a list of the compound's names assigned to each other. Use the data

given in Table No.1 to identify the given samples. Complete Table No.2 to show the chemical name and classification of the samples. Write your answers on a separate sheet of paper.

Table 1: Different Properties of the Samples

Sample	Description	Melting Point (℃)	Boiling Point (℃)	Solubility in Water
A	An odorless, colorless gas at room temperature. Also known as dry ice in solid state	-77	-78.46	Soluble
B	An odorless transparent liquid at room temperature.	0	100	---
C	A sweet white, odorless powder solid at room temperature.	150	---	Soluble
D	A salty white crystalline solid at room temperature.	801	1465	Soluble
E	Liquid at room temperature with strong odor. It is the key ingredient in rubbing alcohol.	-89	82.5	Soluble
F	A white or off-white crystalline powder. It is usually used as flavor enhancer in cooking.	232	333.80	Soluble

Table 2: Chemical name and classification of compounds.

Sample	Chemical Name of Sample	Ionic or Covalent
A	__ A __ B___ ___ ___ ___O___ I D ___	
B	__ __ __ E ___	
C	TABLE S __ __ A __	
D	S __ __ I __M __ __ L __ __ I ___ E	
E	I __ O __P __O __Y__ __L __O__O__	
F	M__ __O__O D__ __ __ __LU__A__ __ __ __	

Guide Questions:

1. What type of compound has high melting point? Why?
2. What type of compound is generally insoluble in water? Why?
3. How do you determine the type of compound based on their melting point, boiling point, and solubility?

Activity 5: Checking Ionic and Covalent Polarity

Find the electronegativity difference of the following pair of elements and identify whether the pair of elements are likely to form an ionic or covalent (polar/nonpolar) compounds. Write your answers on a separate answer sheet.

Pair of Elements	Electronegativity Value	Electronegativity Difference	Polarity of Compound (Ionic/ Polar or Nonpolar Covalent)
1. Sodium Bromine	0.9 2.8		
2. Sulfur Oxygen	2.5 3.5		
3. Hydrogen Oxygen	2.1 3.5		
4. Nitrogen Nitrogen	3.0 3.0		
5. Potassium Chlorine	0.8 3.0		
6. Phosphorous Hydrogen	2.1 2.1		
7. Nitrogen Hydrogen	3.0 2.1		
8. Aluminum Chorine	1.5 3.0		
9. Carbon Hydrogen	2.5 2.1		
10. Sodium Chlorine	0.9 3.0		

Guide Questions:

1. Why do we use electronegativity to determine bond polarity?
2. What kind of elements usually form nonpolar covalent compounds?
3. What is the electronegativity difference of given pair of elements in a nonpolar covalent compound?
4. How can you determine if a pair of elements will result in an ionic compound based on type of elements and electronegativity difference?
5. How can you determine if a pair of elements will result in a polar covalent compound based on type of elements and electronegativity difference?

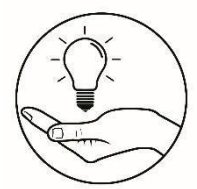
Activity 6: Let's Wrap it Up the Properties of Compounds

Complete the table below to compare the physical properties of ionic from covalent compounds. Check the columns that correctly correspond to its physical properties. Write your answer on a separate sheet of paper.

Physical Properties	Comparative Features	Ionic Compound	Covalent Compound
Types of Elements	metal and nonmetal		
	nonmetal and nonmetal		
Bonding	transfer of electron(s) between atoms		
	sharing of pair(s) of electron(s) between atoms		
Physical State at Room Temperature	gas		
	liquid		
	solid		
	crystalline solid		
Texture/Appearance	soft		
	hard		
	brittle		
	flexible		
Melting Point	high		
	low		
Solubility in water	high solubility		
	low solubility		
Polarity	high polarity		
	low polarity		
Flammability	mostly flammable		
	mostly nonflammable		
Conductor of Heat	good conductor		
	poor conductor		
Electrical Conductivity (s)	Do not conduct electricity		
Electrical Conductivity (aq)	Conduct electricity		

Guide Questions:

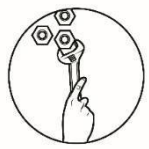
1. How do we identify the different types of compounds?
2. How can knowledge on the different properties of compounds be useful in our daily life?



What I Have Learned

Supply the missing word or words to complete each statement. Write your answers on a separate sheet of paper.

1. Compounds are made up of elements that are chemically bonded by _____ forces.
2. Chemically bonded compounds can be classified into ionic or _____ compound.
3. Ionic compound is formed by complete _____ of electrons from metals to nonmetals, thus ions are formed.
4. Covalent compound is formed when nonmetals _____ their valence electrons with another nonmetal.
5. Like elements, compounds have _____ that allow us to identify them by just observing at a given sample of compound.
6. At normal atmospheric pressure and temperature, _____ compounds exist only in crystalline solids.
7. In general, _____ compounds exist as solid, liquid, or gas at normal atmospheric pressure and temperature.
8. In a compound, polarity results in the distribution of electrical charge over the atoms joined by the bond. Polarity of compounds depend on the _____ difference of elements involves.
9. Compounds that involves metal and nonmetal and has an electronegativity difference of greater than _____ results in an ionic compound.
10. Compounds that involves both nonmetals and has electronegativity difference of less than 1.9 but greater than 0.5 results in a _____ covalent. On the other hand, two identical nonmetals always form _____ covalent like oxygen gas (O_2) and nitrogen gas (N_2).
11. Ionic compounds tend to have _____ polarity, while covalent compounds have _____ polarity.
12. _____ tend to be hard and brittle while _____ tend to be softer and more flexible.
13. _____ exist in stable crystalline structures. Therefore, they have higher melting and boiling points compared to _____.
14. Ionic compounds are usually _____ in water, while covalent compounds tend to be _____ in water.
15. _____ compounds tend to be more flammable than _____ compounds.
16. In a solution, _____ compounds conduct electricity, but not in solid phase.
17. _____compounds are poor conductors of electricity both in solid phase and in solution.
18. _____, that has same chemical formula of water and _____, a type of electrochemical cell that uses chemical reaction to produce electric current, are some examples of natural phenomena that uses the properties of ionic and covalent compounds



What I Can Do

Read each statement below that shows how compounds affect our daily life. Underline the properties of compounds and determine the name and type of compounds involved. Write the type of compounds (ionic/covalent) on the space before each number, then indicate the name or example of compound inside the box. Write your answer on a separate sheet of paper.

_____ 1. [ ] is an electrochemical cell that uses chemical reactions to produce electric current. A battery is an example of voltaic cells, android phone and laptop are just few examples of gadgets that are powered by battery.

_____ 2. [ ] is a colorless liquid at room temperature. It is commonly used as nail polish remover; it is also helpful in removing sticky substances from textiles like cotton and silk.

_____ 3. [ ] is locally known as sukang paombong. It is a cloudy white liquid at room temperature that has a distinct acidic taste and yeasty flavor which are widely used in Filipino cuisine. This vinegar was named after the town of Paombong, Bulacan where it is a traditional industry.

_____ 4. [ ] is a white crystalline volatile solid ball of chemical pesticide and deodorant. It has a distinct odor and used when storing clothing and other articles susceptible to damage from mold or moth larvae.

_____ 5. [ ] does not have a fixed melting point. Instead, as this compound increases in temperature, its molecules begins to decompose producing a more fluid product known as caramel over a wide range of temperatures. This compound exists also in solid at room temperature.

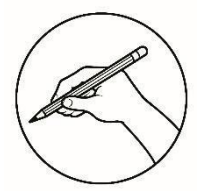
_____ 6. [ ] is usually flammable and mainly used as an engine fuel in vehicles. It is a fuel made from crude oil and other petroleum liquids.

_____ 7. [ ] is a compound with strong conductivity and dissociates completely into charged atoms or ions when dissolved in water. It is commonly used as food seasoning.

_____ 8. [ ] have chemical formula same as water. It begins to form when an extremely cold-water droplet freezes onto a pollen or dust particle in the sky that creates an ice crystal.

_____9. [ ] is a soft and white solid at room temperature. It melts and burns easily. This compound is usually used to make candles.

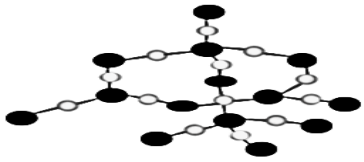
_____ 10. [ ] is a compound that has a bitter, salty taste. At room temperature, it is solid and soluble in water. It is a leavening agent used in baked goods like cakes, muffins, and cookies.



Assessment

Read the following questions carefully. Choose the letter of the correct answer. Write your answer on a separate sheet of paper.

1. What kind of substance is being represented by the structure below?



A. metal
B. nonmetal
C. ionic compound
D. covalent compound

2. Which of the following are the properties of covalent compounds?

I. It is soft and flexible
II. It conducts electricity in a solution
III. It does not conduct electricity both in solid phase and in a solution.
IV. It may exist as solid, liquid, or gas at normal atmospheric pressure and temperature

A. A. I and II only
B. B. II and III only
C. I, II, and III only
D. I, III, and IV only

3. What is the nature of the substances described in the table?

Substances	Appearance	Melting Point
NaCl- sodium chloride	White crystalline solid	801˚C
KCl – Potassium chloride	White or colorless crystal	770˚C
$MgCl_2$ – Magnesium chloride	White or colorless crystalline solid	1412˚C

A. They are ionic compounds and have high melting points.
B. They are ionic compounds and have low melting points.
C. They are covalent compounds and have low melting points.
D. They are covalent compounds and have high melting points.

4. Which of the following statements **BEST** explain why covalent compounds do not conduct electricity when dissolved in water?
   A. Covalent compounds have lower melting point.
   B. Covalent compounds are weakly bonded.
   C. Covalent compounds dissolve into molecules.
   D. Covalent compounds don't dissolve in water since they are composed of non- polar molecules.

5. Which of the following substances does **NOT** conduct electricity?

I. salt solution	III. salt granules
II. sugar solution	IV. monosodium glutamate solution

   A. I only
   B. I and II only
   C. II and III only
   D. I and IV only

6. Which of the following substances do exist in solid, liquid, or gas at room temperature and normal atmospheric pressure?

I. gasoline	II. mothballs	III. salt	IV. water

   A. I only
   B. II only
   C. I, II, III only
   D. I, II and IV only

7. Which of the following pair of elements will result in nonpolar covalent compound?
   A. Aluminum and Chlorine
   B. Phosphorous and Hydrogen
   C. Sulfur and Oxygen
   D. Sodium and Chlorine

8. Which of the following compounds have low melting point?

I. salt	III. paraffin wax
II. sugar	IV. monosodium glutamate

   A. I and II only
   B. II and III only
   C. I, II, and III only
   D. II, III, and IV only

9. Which of the following compound is ionic based on their chemical formula
   A. KCl
   B. HCl
   C. NH_3
   D. $C_{12}H_{22}O_{11}$

10. Which are TRUE about snowflakes?

I.	It is a covalent compound.
II.	All snowflakes are six sided.
III.	II. Its chemical formula is the same as water.
IV.	Its structure is the same as the crystalline lattice of an ionic compound.

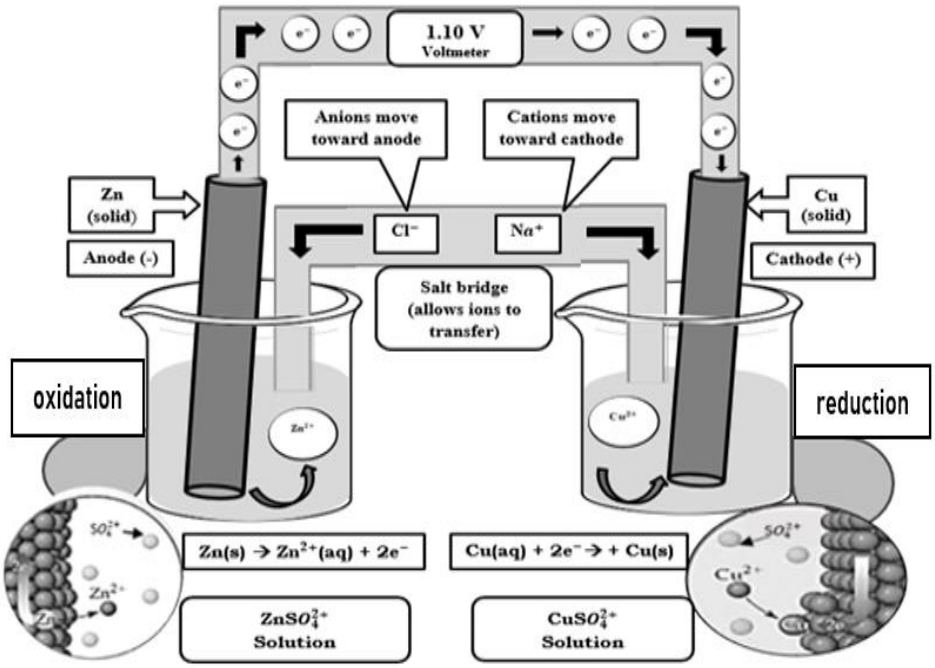
A. I and II only
B. III and IV only
C. I, II, and III only
D. I, II, and IV only

11. Most Filipino athletes consume more ions after a vigorous training by consuming sport drinks and fruits that are rich in electrolytes to replenish lost ions necessary for important bodily functions. Which of the following examples of electrolytes are commonly found in sport drinks?

A. I. glucose II. sodium III. potassium IV. magnesium

A. I and II only
B. II and III only
C. I, II, and III only
D. II, III, and IV only

For questions no. 12-13, refer to the figure below of voltaic cell:



12. How does voltaic cell produce electricity?
A. electrochemical cell
B. oxidation reactions
C. reduction reactions
D. oxidation and reduction reactions

13. Which of the following is/are **TRUE** about voltaic cells as shown in the diagram below?

I. The reaction that takes place in it is reversible. II. They have two conductive electrodes, a positive and negative electrode. III. It is a device that produces electric current from energy released by spontaneous reduction-oxidation reaction.

A. I only B. II only C. I and II only D. II and III only

14. Which of the following shows the **INCORRECT** analogies using the information you can get from the diagram?

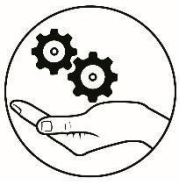
I. anode-reduction: cathode oxidation II. anode-oxidation: cathode reduction III. positive electrode – anode: negative electrode - cathode IV. positive electrode – cathode: negative electrode – anode

A. II only
B. IV only
C. I and III only
D. II and IV only

15. Maria is working as a student assistant in their school Chemistry laboratory. Which of the following shows a direct application of knowledge about the properties of compounds as a student assistant in the Chemistry laboratory?

I. In proper storing of different substances for safety purposes. II. In assisting students when it comes to proper usage of substances. III. In identifying hazardous substances through reading chemical abels. IV. In keeping records of borrowed laboratory tools and equipment in the laboratory.

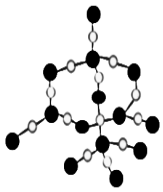
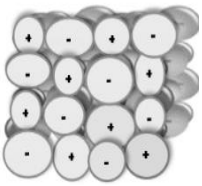
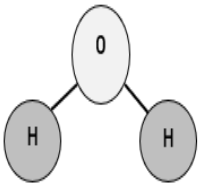
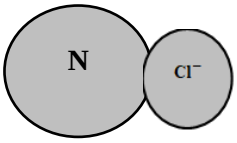
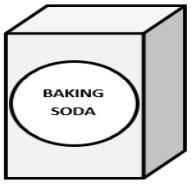
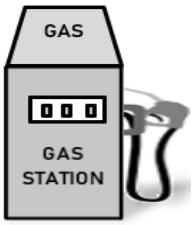
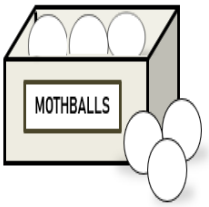
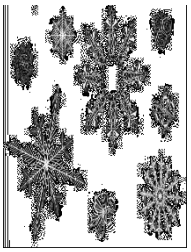
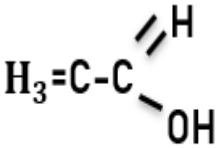
A. I only
B. II only
C. I and II only
D. III and IV only



Additional Activities

Blockout Match!

Write **I** if the block shows an example, a property or natural phenomena (that uses properties of compounds) related to ionic compound and **C** for covalent compound. Write your answer on a separate sheet of paper.

1 	6 HARD	11 	16 ELECTRONEGATIVITY DIFFERENCE IS GREATER THAN 1.9	21 
2 	7 $C_6H_{22}O_{11}$	12 BRITTLE	17 	22 LOW MELTING POINT
3 HIGH BOILING POINT	8 	FREE	18 HIGH MELTING POINT	23 
4 	9 	14 	19 	24 
5 	10 ELECTRONEGATIVITY DIFFERENCE IS LESS THAN 0.5	15 	20  ACETIC ACID	25 

Guide Questions:

1. As a student, why is it important to know and understand the different properties of ionic and covalent compounds?
2. For a scientist, how important is it to have a deeper understanding about the different properties of compound?

Answer Key

What I Know

1. A	11. C
2. B	12. C
3. B	13. D
4. D	14. D
5. D	15. A
6. D	
7. C	
8. B	
9. D	
10. A	

What's In

Group 1A- H, Li, Na, K, Rb, Cs, and Fr
Group IIA- Be, Mg, Ca, Sr, Ba, and Ra
Group IIIA- B, Al, Ga, In, and Tl
Group IVA- C, Si, Ge, Sn, Pb, and Fl
Group VA- N, P, As, Sb, and Bi
Group VIA- O. S, Se, Te, Po, and Lv
Group VIIA- F, Cl, Br, I, and At
Group VIIIA- He, Ne, Ar, Kr, Xe, and Rn

What's New

Compounds	Name of Elements Involved	Types of Elements
1. Water (H_2O)	Hydrogen and Oxygen	Nonmetals
2. Sugar ($C_{12}H_{22}O_{11}$)	Carbon, Hydrogen, and Oxygen	Nonmetals
3. Potassium chloride (KCl)	Potassium and Chlorine	metal and nonmetal
4. Carbon Dioxide (C_2O)	Carbon and Oxygen	Nonmetals
5. Sodium Chloride (NaCl)	Sodium and Chlorine	Metal and nonmetal

Guide Questions:
1. A compound is form when two or more elements bond.
2. A compound contains two or more different elements.

Activity 2 Know My Identity through My Chemical Formula

Chemical Name	Chemical Formula	Ionic / Covalent
1. Water	H_2O	Covalent
2. Borane	BH_3	Covalent
3. Phosphine	PH_3	Covalent
4. Hydrogen gas	H_2	Covalent
5. Nitrogen gas	N_2	Covalent
6. Table sugar	$C_{12}H_{22}O_{11}$	Covalent
7. Sulfur dioxide	SO_2	Covalent
8. Sodium chloride	NaCl	Ionic
9. Aluminum oxide	Al_2O_3	Ionic
10.Carbon monoxide	CO	Covalent
11. Hydrogen fluoride	HF	Covalent
12. Potassium iodide	KI	Ionic
13.Hydrogen chloride	HCl	Covalent
14. Potassium fluoride	KF	Ionic
15.Magnesium chloride	$MgCl_2$	Ionic

Guide Questions:

1. Ionic and covalent compound can be identified and describe using their chemical name and formula. If the element involved in a compound name and formula are metal and nonmetal, then the compound is ionic and if the element involved are both nonmetals, the compound is covalent.

What's More

Activity 1 Out with the Old, In with the New

1. Sodium chloride is composed of metal and nonmetal, while water is composed of both nonmetal elements.

2. Sodium chloride is formed when sodium atoms interact with chlorine atoms by transferring its valence electron to chlorine atom. On the other hand, water is formed when two atoms of hydrogen interact with an atom of oxygen by sharing their valence electrons.

3.Each of the individual atoms in a compound is unstable, to attain their stability the individual atoms transfer or share their valence electrons.

4. Sodium chloride is an ionic compound, while water is a covalent compound.

5. Ionic compounds can be identified if the compound is formed by the transfer of electrons between metal and non-metallic element. On the other hand, covalent compounds involved sharing of pair(s) of electron(s) between non-metallic element.

Activity No.4 Investigating Ionic and Covalent Profile

Sample A - Carbon dioxide – Covalent
Sample B – Water – Covalent
Sample C – Table Sugar – Covalent
Sample D – Sodium Chloride – Ionic
Sample E – Isopropyl Alcohol- Covalent
Sample F – Monosodium Glutamate -Covalent

Guide Questions:

1. Ionic compound has high melting point because strong force of attraction between oppositely charged ions. Therefore, a large amount of heat energy is required to separate the ions.
2. Generally, covalent compound is insoluble in water. This is because water molecules are polar, which means they are favorable to dissolve compounds that are also polar and insoluble for nonpolar molecules.
3. Knowing the physical properties of compound will help you determine the type of compounds that you have. In General, ionic compound has high melting point, boiling point, and solubility compared to covalent compound.

Activity 3 Who Got the Power?

Table 1: Electrical Conductivity of Salt and Sugar Compound.

Sample Compounds	Physical State of Compound (solid/liquid)	Electrical Conductivity Yes/No
A. Salt Granules	Solid	No
B. Sugar Granules	Solid	No
C. Salt Dissolved in Water	Liquid	Yes
D. Sugar Dissolved in Water	Liquid	No

Guide Questions:

1. Salt dissolve in water is the sample compounds that conduct electricity.
2. Salt granules is in solid state. Therefore, ions are not free to move for a charge to flow.
3. Sugar in solid state and in a solution dissolved as molecules and not into ions. Therefore, sugar molecules cannot carry an electric charge.
4. Sugar is composed of nonmetals, therefore, it is an example of covalent compound, while salt is composed of metals, therefore, it is an ionic compound.
5. The type of compound that can conduct electricity is an ionic compound.

Activity 6 Let's Wrap it Up the Properties of Compound

Guide Questions:

1. The physical properties of compounds can be used to identify the different types of compounds.

2. Knowledge about the physical properties of compounds can help us understand how and why certain compounds behave. It can also be used as a guide when it comes to safety and precaution in consuming, handling and storing compounds.

Activity 5 Checking Ionic and Covalent Compound Polarity

	Electronegativity Difference	Polarity of Compound
1.	1.9	Ionic
2.	1	Polar covalent
3.	1.4	Polar covalent
4.	0	Nonpolar covalent
5.	2.2	Ionic
6.	0	Nonpolar covalent
7.	0.9	Polar covalent
8.	1.5	Polar covalent
9.	0.4	Nonpolar covalent
10.	2.1	Ionic

Guide Questions:

1. Electronegativity of an atom refers on how strongly it attracts electron to itself. Electronegativity values of the two atoms involved in a bond affect the polarity of a bond.
2. Two nonmetals that are identical usually formed a nonpolar covalent compound.
3. If the electronegativity difference of a compound is less than 0.4, it is considered as nonpolar covalent.
4. If a pair of elements is composed of metal and nonmetal, and its electronegativity difference is greater than 1.9, this compound is considered as ionic.
5. If a pair of elements is composed of nonmetals and its electronegativity difference is less than 1.9 but greater than 0.4, this compound is considered as polar covalent compound.

What I Have Learned

1. electrostatic force
2. covalent bond
3. transfer
4. share
5. properties
6. ionic
7. covalent
8. electronegativity
9. 1.9
10. polar, nonpolar
11. high, low
12. ionic, covalent
13. ionic, covalent
14. soluble, insoluble
15. covalent, ionic
16. ionic
17. covalent
18. snowflakes, voltaic cell

Activity 6 Let's Wrapped Up the Properties of Compound

Physical Properties	Comparative Features	Ionic Compound	Covalent Compound
Types of Elements	metal and nonmetal	/	
	nonmetal and nonmetal		/
Bonding	transfer of electron(s) between atoms	/	
	sharing of pair(s) of electron(s) between atoms		/
Physical State at Room Temperature	gas		/
	liquid		/
	solid		/
	crystalline solid	/	
Texture/Appearance	soft		/
	hard	/	
	brittle	/	
	flexible		/
Melting Point	high	/	
	low		/
Solubility in water	high solubility	/	
	low solubility		/
Polarity	high polarity	/	
	low polarity		/
Flammability	mostly flammable		/
	mostly nonflammable	/	
Conductor of Heat	good conductor	/	
	poor conductor		/
Electrical Conductivity (s)	Do not conduct electricity	/	/
Electrical Conductivity (aq)	Conduct electricity	/	

Assessment

1. D	6. D	11. D
2. D	7. A	12. D
3. A	8. B	13. D
4. C	9. A	14. C
5. C	10. C	15. C

Additional Activities

1. C	**6. I**	**11. C**	**16. I**	**21. C**
2. I	**7. C**	**12. I**	**17. C**	**22. C**
3. I	**8. I**	**FREE**	**18. I**	**23. C**
4. C	**9. C**	**14. I**	**19. I**	**24. C**
5. C	**10. C**	**15. C**	**20. C**	**25. C**

Guide Questions:

1. As a student knowing and understanding the different properties of ionic and covalent compounds can serve as a guide when it comes in using and consuming certain substance.
2. Deeper understanding of the different properties of compounds help scientist to create more desirable products by manipulating certain properties of compounds.

What I Can Do

Type of Compound	Name of Compound	Underlined Word/s
1. Ionic	Voltaic Cell	electric current
2. Covalent	Acetone	liquid at room temperature
3. Covalent	Nipa palm vinegar/ Sukang Sasa	white liquid at room temperature
4. Covalent	Napthalene balls/ Mothballs	volatile solid
5. Covalent	Sugar	does not have a fixed melting point/ exists also in solid at room temperature
6. Covalent	Gasoline	flammable
7. Ionic	Salt	strong conductivity
8. Covalent	Snowflakes	chemical formula same as water
9. Covalent	Paraffin wax	melts and burns easily
10. Covalent	Baking Soda	At room temperature, it is a solid and soluble in water

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